National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Chemistry and Biology Level 1

This exemplar supports assessment against:

Achievement Standard 92021

Demonstrate understanding of chemical reactions in context

An annotated exemplar is a sample of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade.

New Zealand Qualifications Authority

To support internal assessment

Grade: Achieved
For Achieved, the student needs to demonstrate understanding of chemical reactions in context. This involves describing the reactants and products for a range of chemical reaction types using equations, with reference to conservation of mass. It also involves linking each chemical reaction to a context, using predictable patterns or observations. A range of chemical reactions means at least three different reaction types are required, as outlined in Explanatory Note 2 of the standard. This student has described the reactants and products using equations selected from the Resource Sheet and referred to conservation of mass by stating that matter is not created nor destroyed. The student has also linked the reaction to the context of antacids using the predictable pattern through the evidence. Similar evidence for another two different reaction types is required for an overall grade of Achieved. For Merit, the student could explain the relationship between the reactants and the products in the reaction and use observations from the context of antacids to link the chemical reaction to the context.

Achieved

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(a)	**Use the Resource sheet provided to identify the type of reaction occurring here:** ☑ Neutralisation ☐ Combustion ☐ Decomposition ☐ Precipitation ☐ Combination
(b)	**Explain why you chose this reaction type.** *You should use:* *- your own observations of reactants and products* *- generic word equations and any other relevant information on the resource sheet* *- predictable patterns of the reactions you studied in class.* I know it was this type of reaction because...

As seen in the observations, the hydrochloric acid solution was previously red before, as they added the magnesium hydroxide powder, it dissolved then colour changed into green. They only added 5mL of magnesium hydroxide powder. In other words, this tells us that the ~~HCl (acid) +~~ HCl (acid) Combined with the Mg(OH) (base) resulted in the neutralisation of acid. This is because the acid contains H^+ (Hydrogen ions) & the base contains OH^- (Hydroxide ions), when it both releases H^+ & OH^-, the ~~acidity~~ base cancels out the acidity & neutralises it. This is also why the UI colour went from red ~~to green~~ → orange → yellow → green. Additionally, ~~From the combination of H^+ (Hydrogen ions) & OH^- (Hydroxide ions),~~ (acid) (neutral) when the HCl containing H^+ (acids) combined with the Mg(OH) containing OH^- (bases), they released & mixed which is also how ~~the~~ salt would form. The salt in this case was the magnesium chloride.

(c)	**Explain how mass is conserved in this chemical reaction.**

I know that mass was conserved because...

the chemical equation ~~for~~ is ~~Hydrochloric~~ $2HCl + Mg(OH)_2 \rightarrow MgCl + 2H_2O$
And the ~~balanced~~ the generic chemical equation is
acid + base (metal oxide or hydroxide) → ionic salt + water.
~~We can see the~~ $2HCl + Mg(OH)_2 \rightarrow MgCl + 2H_2O$.

4 =H 1=Cl → 1=Mg 4=H

1=Mg 1=O 1=Cl 1=O

Looking at the chemreal equation, I can see that the reactants on the left side have the same amount of atoms on the right side which is the products. Furthermore, the law of conservation of mass states that mass cannot be destroyed or created, it can only be transferred. The chemical equation proves this because we can see that the reactants have the same amount products. Ultimately, mass was conserved.

(d) **To successfully digest protein in your stomach, the pH must be between pH 1 and 3. A friend suggests that you might feel better if you took 3 times the recommended dose of Mylanta.**
What might be the implication (effect) of doing this on successful digestion of any protein in your stomach?

By taking x3 of the recommened amount of Mylanta, it would still go into the process of neutralisation. The hydrochloric acid in the stomach will combined with the base, in this case it is Mylanta. It will neutralise the acidity in the stomach, however, ~~th~~ because of the excess amount of ~~base (hydrochloric~~ magnesium hydroxide (mylanta), the stomach will ~~not be an at~~ now cause ~~br~~ indigestion in the stomach & cause heartburns. 15mL was more than enough because to cancel out the acidity, you would only need 5mL to cancel out the ~~th~~ acidity in the stomach.

(e) **5mL of Mylanta (magnesium hydroxide) needed to be added to 10mL of hydrochloric acid before the green colour appeared.**
Explain how this observation relates to the balanced chemical equation.

This observation relates to the balance chemical equation of:
$2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2H_2O$
So when 5mL of Mylanta (the magnesium hydroxide) → (base) was dropped into the 10mL of hydrochloric acid, the mixture turned green because of the H^+ ions & the OH^- ions released & combined, resulting in the neutralisation of the hydrochloric acid. The mixture caused salt to be formed which was the $MgCl_2$. ~~and it also forms water~~ The water was also present after the neutralisation.
The generic chemical equation that proves this is:
acid + base (metal oxide or hydroxide) → ionic salt + water.

$$2HCl + Mg(OH)_2 \longrightarrow MgCl_2 + 2H_2O$$

Grade: Merit
For Merit, the student needs to explain chemical reactions in context. This involves explaining the relationship between the reactants and products for the range of chemical reactions using equations, with reference to conservation of mass. It also involves explaining how each chemical reaction links to a context, using predictable patterns and observations. This student has explained the relationship by showing how the elements in the reactants rearrange into the products supported by the balanced chemical equation and shows how the quantity of each element is the same in the reactants and products. The student has also used both observations (found in questions 1c, 2a, and 3) and the predictable pattern (in question 1b) to explain how the reaction links to the context of sparklers. Similar evidence for another two different reaction types is required for an overall grade of Merit. For Excellence, the student could discuss an implication of conservation of mass for the reaction in the context of sparklers.

Merit

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1(a) Using the Resource sheet provided, identify the reaction type occurring here:

- ☐ Neutralisation
- ☐ Combustion
- ☐ Decomposition
- ☐ Precipitation
- ☑ Combination

1(b) Justify your answer to 1(a), by linking to the observations and the predictable pattern expected for this type of chemical reaction.

I identified this as a combination chemical reaction because the generic word equation for a combination reaction is: metal + non-metal → ionic compound. In this situation aluminium (4Al) from the sparkler is ignited in the air causing it to react with the oxygen ($3O_2$) to form aluminium oxide ($2Al_2O_3$)

metal + nonmetal → ionic compound

aluminium(s) (4Al) + oxygen (g) ($3O_2$) → aluminium oxide (s) ($2Al_2O_3$)

1(c) Use the recorded observations to identify the reactants and products and qualitatively describe in terms of the elements present, why mass is conserved.

Reactants: For our reactants we have solid aluminium(4Al) ~~and~~ which is a shiny, silvery solid and Oxygen(O_2) from the air which is a colourless odourless gas.

Products: On the products we have a white solid ionic compound which is aluminium oxide ($2Al_2O_3$).

The law of conservation of mass states that mass of reactants = mass of products.

We can see that the reactants, aluminium (4Al) and oxygen ($3O_2$) fully reacted into aluminium oxide ($2Al_2O_3$) as the sparkler is unable to reignite

Mass is conserved.

2(a) Explain how the recorded observations match the changes expected by the predictable pattern for this type of reaction.

The recorded observations match the changes expected ~~for~~ by the predictable pattern for combination reactions because it was expected that aluminium (4Al) ~~was~~ (the metal) would react with the oxygen ($3O_2$) non metal in the air after being ignited, to then form a white powder/solid called aluminium oxide ($2Al_2O_3$) which is a combination of the two reactants. ionic compound.

2(b) Explain how the balanced chemical equation (given below), shows that mass is conserved by considering how the reactants turn into products.

You should discuss:

- The types of atoms present.
- The number of atoms of each type (this can be shown by a table or a diagram)
- How all of the atoms present in the reactants are rearranged to form the products.

There are only 2 types of atoms in the chemical equation. Namely, they are aluminium (4Al) and oxygen (O_2). In the reactans side there is 4 x aluminium from 4Al and 6x Oxygen from $3O_2$. On the products side there are 4 x aluminium and 6x oxygen from aluminium oxide ($2Al_2O_3$). Table:

$4Al + 3O_2 \longrightarrow 2Al_2O_3$

Al : 4	Al : 4
O : 6	O : 6

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The aluminium ions and oxygen ions react together to form aluminium oxide. From our table we can see that both sides of the chemical equation have the same amount of aluminium atoms (4 of them) and Oxygen atoms (6 of them). This shows that mass is conserved as no new atoms have been created and no atoms have been lost.

3	Using your understanding of conservation of mass, discuss the possible implications (effects) if the manufacturer **reduced** the amount of potassium chlorate in the sparkler.

If the manufactuer had reduced the amount of potassium chlorate in the sparkler the chemical reaction between aluminium (4Al) and oxygen($3O_2$) would occur much slower because the concentration of Oxygen($3O_2$) in the air is to low. This is because potassium chlorate helps make the sparkler sparkle more vigoursly and with out it the reaction is ~~little~~. Also this could affect the conservation of mass as without potassium chlorate the concentration of oxygen in the air becomes insufficient which could cause an inbalance in aluminium (4Al) and Oxygen($3O_2$) atoms on the products vs the reactants side. After the students experiment his sparkler was unable to reignite with potassium chlorate. If potassium chlorate was reduced, the chemical reaction may not have reacted fully reacted meaning there may be unreacted aluminium (4Al) and Oxygen($3O_2$) atoms which could possibly react after reignition.

Grade: Excellence
For Excellence, the student needs to interpret chemical reactions in context. This involves discussing the implications of conservation of mass in the context of each chemical reaction, with reference to predictable patterns, observations, and equations. This student has discussed an implication of conservation of mass related to the combustion context of cooking with natural gas. The student used conservation of mass to discuss the observation of soot forming on the outside of the pot when there was a decrease in the amount of oxygen available to react with methane. This is linked to predictable patterns, observations, and equations (both complete and incomplete combustion). Similar evidence for two other different reaction types is required for an overall grade of Excellence.

Excellence

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Context ONE: **Cooking with Natural Gas**

1. Natural gas contains a colourless gas called methane (CH_4) and is used in many homes for cooking or heating. When a student was at home, they used a saucepan to boil some water to cook pasta - they noticed that the flame was blue, and initially, some water condensed on the outer surface of the pot. An air quality monitor showed increasing levels of carbon dioxide.

carbon dioxide levels

From the context above and the resource sheet, identify the following:

The **observations**	they noticed a blue flame, moisture condensing around surface of the pot, air quality monitor shows increasing
The **reactants**	methane (CH_4) and oxygen (O_2)
The **products**	carbon dioxide (CO_2) and water (H_2O)
Word equation	methane + oxygen → carbon dioxide + water
Balanced chemical equation	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

2. Identify the type of reaction this is and the **predictable pattern**

Generic equation from the resource sheet	Type of reaction
carbon compound + oxygen (excess) → carbon dioxide + water.	complete combustion.

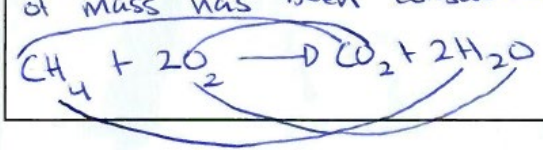
Explanation

It fits the predictable pattern of complete combustion because a carbon compound (methane) combusts in excess oxygen to produce carbon dioxide and water.

3. Explain how the balanced chemical equation shows that **mass is conserved** by considering how the reactants turn into the products.

You should discuss:
- The types of atoms **present**.
- The number of atoms **of** each type (this can be shown **by a table** or diagram).
- How **all of the** atoms originally present in the reactants are rearranged to form the products.

The Law of Conservation of mass states that matter cannot be created nor destroyed, therefore mass of reactants must equal to mass of products. In this combustion reaction, $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, methane combusts in sufficient oxygen to produce carbon dioxide and water. From the reactants, C, H, O rearrange into new combinations to create the products. The 1C from CH_4 combines with 2O in $2O_2$ to create the 1C in CO_2. Similarly, the 4H in CH_4 combine with 2O from $2O_2$ to produce the 4H in $2H_2O$. In the reactants, C, H, O simply rearrange into new combinations, showing that mass has been conserved. This shows that there are the same type and number of atoms in products, as they were in reactants. The total mass of carbon dioxide and water is equivalent to total mass of methane and oxygen. Therefore, shows that law of conservation of mass has been conserved.



Reactants:	Products:
C = 1	C = 1
H = 4	H = 4
O = 4	O = 4

4. Using the **observations** from the information above and the **predictable pattern**, explain how this reaction **links to the context.**

You may also include **observations from laboratory experiments** if these will help your explanation.

In this reaction, you can see that $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, a colourless gas methane combusts in colourless gas oxygen to produce CO_2 and water. This is complete combustion because observations such as blue flame, moisture condensing on outer surface of pot, and colourless gas given off during the reaction (turns lime water cloudy which is a positive test for CO_2, during lab experiments).

- The blue flame indicates sufficient supply of oxygen, indicating complete combustion.
- The colourless liquid was identified as water. (It turns blue cobalt chloride paper pink during lab experiments).

These observations are consistent with the predictable pattern of complete combustion.

5. *Due to their kitchen being renovated, the student's parents decided to cook in their garage and shifted the stove and other cooking materials to the small enclosed garage, which did not have any windows. They also noticed that the bottom of the saucepan was "dirty" and left a black solid on a cloth when it was cleaned and the flame was yellow. The equation for this reaction is*

2 : 3
1 : 1.5 per methane molecule

a. Discuss how **conservation of mass explains the observed differences** in the products between this reaction and the one described in question 1.

$(2CH_4 + 3O_2 \rightarrow C + CO_2 + 4H_2O)$

b. **Compare and contrast the consequences** for people and the home environment between using a blue or yellow flame for cooking or heating.
Use the predictable patterns, observations and equations to help you do this.

The law of conservation of mass states that matter cannot be created nor destroyed. (mass of reactants must equal to mass of products). The products depend on how many O_2 are available to react. When, there were $2O_2$ available per methane molecule, all H atoms initially reacted with any available O_2 to produce H_2O. Then, C reacted with any remaining O_2 to produce carbon dioxide. However, when there were $1.5O_2$ molecules per methane molecule, all H atoms firstly reacted with available O_2 to produce H_2O. Any remaining O_2 reacted with C to produce CO_2, but there were more C than O_2, and since the supply of oxygen was insufficient some carbon atoms remained unreacted as carbon/soot. The unburnt carbon glows yellow/orange in the flame when heated.

Similarities:
In both complete and incomplete combustion, all H atoms will initially react with available O_2, to produce H_2O. (If the supply of oxygen is insufficient for that to happen, then no combustion reaction will take place at all).

- both complete and incomplete combustion produce heat energy.
- the H_2O produced contributes to damp houses, promotes mold growth, and even allergic reactions etc.

the supply of oxygen was sufficient

the supply of oxygen was insufficient.

Differences:

- The complete combustion in q.1 produces a hotter blue flame, which has shorter cooking times and is more energy efficient.
- The incomplete combustion in q.5 produces a cooler yellow flame, which has longer cooking times and is less energy efficient, using more fuel.
- One of the products produced in incomplete combustion is carbon/soot, which can lead to:
  - can cause health issues related to lungs/breathing
  - cause discolouration of pots and walls.
  - reduce the amount of photosynthesis taking place, as it blocks leaves from recieving sunlight, which can lead to less oxygen being produced.